526 Rec'd PCT/PTO 19 JAN2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

REQUEST FOR FILING NATIONAL PHASE OF PCT APPLICATION UNDER 35 U.S.C. 371 AND 37 CFR 1.494 OR 1.495

09/744015

To: Hon. Commissioner of Patents
Washington, D.C. 20231

00909

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US)

Atty Dkt: **PM** 276617 /T298060 US
M# /Client Ref.

From: Pillsbury Madison & Sutro LLP, IP Group: Date: January 19, 2001

This is a **REQUEST** for **FILING** a PCT/USA National Phase Application based on:

1. International Application	2. International Filing Date	3. Earliest Priority Date Claimed
PCT/FI99/00635	21 July 1999	22 July 1998
⇧ country code	Day MONTH Year	Day MONTH Year (use item 2 if no earlier priority)

4. Measured from the earliest priority date in item 3, this PCT/USA National Phase Application Request is being filed within:

(a) ☐ 20 months from above item 3 date (b) ☒ 30 months from above item 3 date,

(c) Therefore, the due date (unextendable) is January 22, 2001

5. Title of Invention DATA TRANSMISSION METHOD, RADIO NETWORK SUBSYSTEM, AND USER EQUIPMENT

6. Inventor(s) HOLMA, Harri et al

Applicant herewith submits the following under 35 U.S.C. 371 to effect filing:

7. ☒ Please immediately start national examination procedures (35 U.S.C. 371 (f)).

8. ☐ **A copy of the International Application** as filed (35 U.S.C. 371(c)(2)) is transmitted herewith (file if in English but, if in foreign language, file only if not transmitted to PTO by the International Bureau) including:

a. ☐ Request;
b. ☐ Abstract;
c. _____ pgs. Spec. and Claims;
d. _____ sheet(s) Drawing which are ☐ informal ☐ formal of size ☐ A4 ☐ 11"

9. ☒ **A copy of the International Application has been transmitted by the International Bureau.**

10. **A translation of the International Application** into English (35 U.S.C. 371(c)(2))
a. ☒ is transmitted herewith including: (1) ☒ Request; (2) ☒ Abstract;
(3) 25 pgs. Spec. and Claims;
(4) 11 sheet(s) Drawing which are:
☐ informal ☒ formal of size ☒ A4 ☐ 11"
b. ☐ is not required, as the application was filed in English.
c. ☐ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.
d. ☐ Translation verification attached (not required now).

11. ☒ **PLEASE AMEND** the specification before its first line by inserting as a separate paragraph:
a. ☒ --This application is the national phase of international application PCT/FI99/00635 filed July 21, 1999 which designated the U.S, and that international application ☒ was ☐ was not published under PCT Article 21(2) in English.--
b. ☐ --This application also claims the benefit of U.S. Provisional Application No. 60/ _____, filed _____ .--

12. ☐ Amendments to the claims of the International Application **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., before 18th month from first priority date above in item 3, are transmitted herewith (file only if in English) including:**

13. ☒ PCT Article 19 claim amendments (if any) have been transmitted by the International Bureau

14. ☐ Translation of the amendments to the claims **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., of claim amendments** made before 18th month, **is attached (required by 20th month from the date in item 3 if box 4(a) above is X'd, or 30th month if box 4(b) is X'd, or else amendments will be considered canceled).**

15. **A declaration of the inventor** (35 U.S.C. 371(c)(4))
a. ☐ is submitted herewith ☐ Original ☐ Facsimile/Copy
b. ☒ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.

16. **An International Search Report (ISR):**
a. Was prepared by ☐ European Patent Office ☐ Japanese Patent Office ☒ Other
b. ☒ has been transmitted by the international Bureau to PTO.
c. ☒ copy herewith (2 pg(s).) ☒ plus Annex of family members (1 pg(s).).

17. **International Preliminary Examination Report** (IPER):
a. ☒ has been transmitted (if this letter is filed after 28 months from date in item 3) in English by the International Bureau with Annexes (if any) in original language.
b. ☒ copy herewith in English.
c.1 ☐ IPER Annex(es) in original language ("Annexes" are amendments made to claims/spec/drawings during Examination) including attached amended:
c.2 ☐ Specification/claim pages #_____ claims #
Dwg Sheets #
d. ☐ Translation of Annex(es) to IPER **(required by 30th month due date, or else annexed amendments will be considered canceled).**

18. **Information Disclosure Statement** including:
a. ☒ Attached Form PTO-1449 listing documents
b. ☐ Attached copies of documents listed on Form PTO-1449
c. ☒ A concise explanation of relevance of ISR references is given in the ISR.

19. ☐ **Assignment** document and Cover Sheet for recording are attached. Please mail the recorded assignment document back to the person whose signature, name and address appear at the end of this letter.

20. ☐ Copy of Power to IA agent.

21. ☐ **Drawings** (complete only if 8d or 10a(4) not completed): ___ sheet(s) per set: ☐ 1 set informal; ☐ Formal of size ☐ A4 ☐ 11"

22. Small Entity Status ⌀ ☒ is **Not** claimed ☐ is claimed (**pre**-filing confirmation required)
22(a) _____ (No.) Small Entity Statement(s) enclosed (since 9/8/00 Small Entity Statements(s) not essential to make claim)

23. **Priority** is hereby claimed under 35 U.S.C. 119/365 based on the priority claim and the certified copy, both filed in the International Application during the international stage based on the filing in (country) FINLAND of:

	Application No.	Filing Date		Application No.	Filing Date
(1)	981649	July 22, 1998	(2)		
(3)			(4)		
(5)			(6)		

a. ☒ See Form PCT/IB/304 sent to US/DO with copy of priority documents. If copy has not been received, please proceed promptly to obtain same from the IB.
b. ☐ Copy of Form PCT/IB/304 attached.

RE: USA National Filing of PCT/FI99/00635

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24. Attached:

25. **Preliminary Amendment:**

25.5 Per Item 17.c2, **cancel original** pages #_____, claims #_____, Drawing Sheets #

26. **Calculation of the U.S. National Fee (35 U.S.C. 371 (c)(1)) and other fees is as follows:**
Based on amended claim(s) per above item(s) ☐ 12, ☐ 14, ☐ 17, ☐ 25, ☐ 25.5 (hilite)

Total Effective Claims	minus 20 =	x $18/$9 =	$0	966/967
Independent Claims	minus 3 =	x $80/$40 =	$0	964/965
If any proper (ignore improper) Multiple Dependent claim is present,		add$270/$135	+0	968/969

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4)): →→ **BASIC FEE REQUIRED, NOW** →→→→

A. If country code letters in item 1 are **not** "US","BR","BB","TT","MX","IL" "NZ", "IN" or "ZA"

See item 16 re:

1.	Search Report was not prepared by EPO or JPO - - - - - - - - -	add$1000/$500		960/961
2.	Search Report was prepared by EPO or JPO - - - - - - - - - - -	add$860/$430	+1000	970/971

SKIP B, C, D AND E UNLESS country code letters in item 1 are "US","BR","BB","TT","MX","IL", "NZ", "IN" or "ZA"

→ (X) ☐	B. If USPTO did not issue both International Search Report (ISR) and (if box 4(b) above is X'd) the International Examination Report (IPER), - - - - - - - - - - - - - - - - - - -	add$970/$485	+0	960/961
(only) (one) → (of) ☐	C. If USPTO issued ISR but not IPER (or box 4(a) above is X'd), -	add$710/$355	+0	958/959
(these) (4) → (boxes) ☐	D. If USPTO issued IPER but IPER Sec. V boxes not all 3 YES, -	add$690/$345	+0	956/957
→ ☐	E. If international preliminary examination fee was paid to USPTO and Rules 492(a)(4) and 496(b) satisfied (IPER Sec. V all 3 boxes YES for all claims), - - - - - - - - - - - - -	add $100/$50	+0	962/963
27.		**SUBTOTAL =**	$1000	
28.	If Assignment box 19 above is X'd, add Assignment Recording fee of ----$40		+0	(581)
29.	Attached is a check to cover the -	**TOTAL FEES**	$1000	

Our Deposit Account No. 03-3975
Our Order No. 60258 (C#) | 276617 (M#)

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CHARGE STATEMENT: The Commissioner is hereby authorized to charge any fee specifically authorized hereafter, or any missing or insufficient fee(s) filed, or asserted to be filed, or which should have been filed herewith or concerning any paper filed hereafter, and which may be required under Rules 16-18 and 492 (missing or insufficient fee only) now or hereafter relative to this application and the resulting Official document under Rule 20, or credit any overpayment, to our Account/Order Nos. shown above for which purpose a duplicate copy of this sheet is attached.
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Pillsbury Winthrop LLP
Intellectual Property Group

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NOTE: File in duplicate with 2 postcard receipts (PAT-103) & attachments.

09/744015

APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No. PM 276617/T298060US
(M#)

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Invention: DATA TRANSMISSION METHOD, RADIO NETWORK SUBSYSTEM, AND USER EQUIPMENT

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This is a:

- ☐ Provisional Application
- ☐ Regular Utility Application
- ☐ Continuing Application
  - ☒ The contents of the parent are incorporated by reference
- ☒ PCT National Phase Application
- ☐ Design Application
- ☐ Reissue Application
- ☐ Plant Application
- ☐ Substitute Specification
  Sub. Spec Filed _____
  in App. No. _____ / _____
- ☐ Marked up Specification re
  Sub. Spec. filed _____
  In App. No _____ / _____

SPECIFICATION

DATA TRANSMISSION METHOD, RADIO NETWORK SUBSYSTEM, AND USER EQUIPMENT

FIELD OF THE INVENTION

The invention relates to a method for transmitting data from a radio network subsystem to user equipment in a mobile telephone system. In particular, the invention relates to the use of spreading codes in a universal mobile telephone system.

BACKGROUND OF THE INVENTION

One of the biggest problems in mobile telephone systems is an efficient use of a limited radio resource. In present systems, a certain quantity of resources, for instance one spreading code, is reserved for each user for a circuit switched call during the entire radio link. The problem occurs, because not only is user data continuously transmitted, but system control data must also be transmitted at sporadically or regularly repeating intervals. Another problem relates to the operation of user equipment in slotted mode, in which the user equipment measures the received power of other frequencies of adjacent base transceiver stations for part of the duration of the radio frame. In this case, the user equipment cannot receive normally, but may even loose the entire radio frame.

For instance, in systems using the code division multiple access method (CDMA) one spreading code with spreading factor 256 is reserved for each connection on a downlink from the radio network subsystem to the user equipment. This spreading factor is enough to transmit user data, but when it is necessary to transmit control data, coding must be cut down too much. One solution to the problem is to replace user data with system control data, but in this case some of the user data would be lost, and when transmitting speech, for instance, this would be noticeable as a decrease in speech quality, even breaking.

Another solution to the first problem is to reserve data transmission resources in a manner that there is enough of them all the time. In this case, a spreading code with spreading factor 128, for instance, is reserved for the connection. A problem occurs, however, because the need for transmission resources is calculated on the basis of the momentary maximum required and thus transmission resources are wasted during most of the time when control data need not be transmitted. In theory, it is possible to use 128 different

spreading codes simultaneously, but, as in certain cases even 25 to 30% of users are performing soft handovers at the same time, there are, in practice, less than a hundred spreading codes left to use.

Used spreading codes can be arranged in a code tree in which the spreading codes used in the system are arranged mutually orthogonally. When moving deeper into the tree, the length of the spreading codes doubles on each level, thus halving the data transmission speed. One suggested solution to the second problem above is that adjacent spreading codes on one level, i.e. sibling codes, be reserved for two different users. The spreading factor of the sibling codes can be 256, for instance. When necessary, one of the users can then obtain the parent code of said spreading codes, i.e. a code one level up with spreading factor 128. However, this solution entails that the users are synchronized with each other, because the first user cannot use its own sibling code while the second user uses the parent code. The first user equipment can thus make measurements during the first half of a normal frame and receive a shortened frame spread with the parent code during the second half, in which case its data transmission capacity corresponds to a normal frame spread with the sibling code. The second user equipment receives a shortened frame spread with the parent code during the first half of the frame and makes measurements during the second half. In normal operation, both sets of user equipment receive normal frames spread with their own sibling codes. The required synchronization is a considerable limitation to the flexibility of the system.

BRIEF DESCRIPTION OF THE INVENTION

It is thus an object of the invention to develop a method and an apparatus implementing the method in a manner that solves the above problems. This object is achieved by a method described in the following. It is a method for transmitting data from a radio network subsystem over a radio link to user equipment in a mobile telephone system, which comprises: the radio network subsystem transmits a dedicated physical channel to the user equipment, which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and the dedicated physical channel is formed by frames to be transmitted to the radio link; during transmission, the radio network subsystem spreads each channel with a spreading code, the length of which spreading code, i.e. spreading factor,

determines the data transmission rate, and a spreading code to be used in normal situations is reserved for the radio link. In the method in question, in a special situation at least one frame of the dedicated physical data channel is spread with a shared spreading code which is shorter than the spreading code used in normal situations, and the shared spreading code in question is shared by time division between the dedicated physical data channels of at least two different radio links.

A further object of the invention is a radio network subsystem which is adapted to transmit a dedicated physical channel over a radio link to the user equipment, which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and to form a dedicated physical channel from the frames to be transmitted to the radio link; to spread each channel with a spreading code during transmission, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and to reserve a spreading code to be used in normal situations for the radio link. The radio system is adapted to spread in a special situation at least one frame of the dedicated physical data channel with a shared spreading code which is shorter than the spreading code used in normal situations, and to share the shared spreading code in question by time division between the dedicated physical data channels of at least two different radio links.

A yet further object of the invention is user equipment which is adapted to receive a dedicated physical channel transmitted by the radio network subsystem over a radio link, which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and to form a dedicated physical channel from the frames to be received from the radio link; to remove during reception the spreading of each channel with a spreading code, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and to use in normal situations the spreading code reserved for the radio link for normal situations to remove the spreading. In special situations, the user equipment is adapted to remove the spreading of at least one frame of the dedicated physical data channel with a shared spreading code which is shorter than the spreading code used in normal situations and which is used by time division between the dedicated physical data channels of at least two different radio links.

The preferred embodiments of the invention are set forth in the dependent claims.

The invention is based on the fact that a common code resource distributed to different radio links is reserved for the spreading of dedicated physical data channels. In normal situations, each radio link uses its own code resource, but in special situations, a radio link can use the shared code resource. The individual code resource of a radio link and the shared code resource are in no way dependent on each other, i.e. they can be used simultaneously.

The method of the invention provides several advantages. The data transmission rate can be changed quickly, even specifically for each frame, by selecting a suitable spreading code. This enables an efficient utilization of radio resources.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described in greater detail in connection with preferred embodiments and with reference to the attached drawings, in which

Figures 1A and 1B show a mobile telephone system,

Figure 2A shows a transmitter and receiver of a mobile telephone system,

Figure 2B illustrates the spreading and modulation performed in a transmitter,

Figure 3 shows the channels of a mobile telephone system set in frames,

Figure 4A shows a code tree,

Figure 4B illustrates the allocation of codes according to the invention,

Figure 5 shows user equipment,

Figures 6A and 6B show flow charts illustrating action of the invention,

Figure 7A illustrates sharing of the use of a spreading code according to the invention, and

Figure 7B shows an enlarged detail of Figure 7A, which illustrates how different spreading codes can be used within a frame.

DETAILED DESCRIPTION OF THE INVENTION

The invention can be used in various mobile telephone systems that use the code division multiple access method (CDMA). The examples illustrate the use of the invention in a universal mobile telephone system using a direct-sequence wide-band code division multiple access method, without limiting the invention to it, however. Thus, for instance the IMT-2000 mobile telephone system developed by ARIB (Association of Radio Industries and Businesses) in Japan is a system of the invention. The examples are based on the specification of the WCDMA system, further information on which is available in the ETSI (European Telecommunications Standards Institute) specification "The ETSI UMTS Terrestrial Radio Access (UTRA) ITU-R RTT Candidate Submission (Tdoc SMG2 260/98, May/June 1998), which is incorporated herein by reference.

The structure of a universal mobile telephone system is described with reference to Figures 1A and 1B. Figure 1B includes only the blocks that are essential for describing the invention, but it is obvious to those skilled in the art that a common mobile telephone system also contains other functions and structures which need not be described in detail herein. The main parts of a mobile telephone system are a core network CN, a universal mobile telephone system (UMTS) terrestrial radio access network UTRAN, and user equipment UE. The interface between CN and UTRAN is referred to as Iu and the air interface between UTRAN and UE is referred to as Uu.

UTRAN comprises radio network subsystems RNS. The interface between RNSs is referred to as Iur. An RNS comprises a radio network controller RNC and one or more nodes B. The interface between RNC and B is referred to as Iub. The service area of node B, i.e. cell, is indicated with C in Figure 1B.

As the presentation in Figure 1A is very abstract, it is therefore clarified in Figure 1B by setting forth the parts of the GSM system that approximately correspond with the parts of the UMTS. It should be noted that the mapping shown is by no means a binding one but an approximation, since the responsibilities and functions of the different parts of the UMTS are still being planned.

As shown in Figure 1B, a circuit-switched connection can be established from user equipment UE to a phone 100 in a public switched telephone network (PSTN) 102. The user equipment UE can, for instance, be

a fixed terminal, a terminal arranged in a vehicle, or a portable terminal. The infrastructure of a radio network UTRAN comprises radio network subsystems RNS, i.e. base transceiver station systems. A radio network subsystem RNS comprises a radio network controller RNC, i.e. a base station controller, and at least one node B, i.e. base transceiver station, under its control.

The base transceiver station B has a multiplexer 114, transceivers 116 and a control unit 118 which controls the operation of the transceivers 116 and the multiplexer 114. With the multiplexer 114, the traffic and control channels used by several transceivers 116 are placed in the transmission link Iub.

The transceivers 116 of the base transceiver station B are connected to an antenna unit 120 which implements a bi-directional radio link Uu to user equipment UE. The structure of the frames to be transmitted over the bi-directional radio link Uu is clearly specified.

The radio network controller RNC comprises a group switching field 110 and control unit 112. The group switching field 110 is used to connect speech and data and to connect signalling circuits. The base station system formed by the base transceiver station B and the radio network controller RNC also comprises a transcoder 108. Work distribution between the radio network controller RNC and the base transceiver station B as well as their physical structure can vary depending on implementation. Typically, the base transceiver station B takes care of the radio path implementation as described above. The radio network controller RNC typically takes care of the following: management of radio resources, control of handover between cells, power adjustment, timing and synchronization, paging the user equipment.

The transcoder 108 is usually located as close as possible to a mobile switching centre 106, because speech can then be transmitted in mobile telephone system format between the transcoder 108 and the radio network controller RNC saving transmission capacity. The transcoder 108 converts the different digital coding formats of speech used between the public switched telephone network and the mobile telephone network to be compatible with each other, for instance from the 64 kbit/s format of a public network to another (e.g. 13 kbit/s) format of a cellular network and vice versa. The hardware required is not described in detail herein, but it can be noted that other data than speech is not converted in transcoder 122. The control

unit 112 takes care of call control, mobility management, collection of statistics, and signalling.

Core network CN comprises an infrastructure belonging to a mobile telephone system and external to UTRAN. Figure 1B describes two of the components in a core network CN, i.e. a mobile switching centre 106 and a gateway mobile switching centre 104 which handles the connections of the mobile telephone system to the outside world, in this case, to the public switched telephone network 102.

Figure 5 shows an example of the structure of user equipment UE. The essential parts of user equipment UE are: interface 504 to the antenna 502 of the user equipment, transceiver 506, control part 510 of the user equipment, and interface 512 to the battery 514. The user interface usually comprises a display 500, keyboard 508, microphone 516, and loudspeaker 518.

Figure 2A describes the operation of a radio transmitter - radio receiver pair. Figure 2A describes a case of downlink where the radio transmitter is located in node B and the radio receiver in the user equipment UE.

The upper part of Figure 2A describes the essential functions of the radio transmitter. Various services located in the physical channel include speech, data, moving or still video picture, and control channels of the system which are processed in the control part 214 of the radio transmitter. The figure shows the processing of the control channel and data. Different services require different source coding means, for instance speech requires a speech codec. For clarity's sake, source coding means are not, however, described in Figure 2A.

Different channel coding is then performed for different channels in blocks 202A and 202B. Channel coding includes, for instance, different block codes, an example of which is cyclic redundancy check (CRC). In addition, convolution coding and its various modifications, such as punctured convolution coding or turbo coding, are typically used.

When the different channels have been channel-coded, they are interleaved in an interleaver 204A, 204B. The purpose of interleaving is to facilitate error correction. In interleaving, the bits of different services are mixed in a certain manner together, in which case a momentary fade in the radio path does not necessarily make the transmitted information

unidentifiable. The interleaved bits are then spread with a spreading code, scrambled with a scrambling code and modulated in block 206A, 206B, the operation of which is described in greater detail in Figure 2B. Individual signals are combined in block 208 to be transmitted through one transmitter.

Finally, the combined signal is forwarded to radio frequency parts 210 which can comprise different power amplifiers and filters restricting bandwidth. The analogous radio signal is then transmitted through an antenna 212 to radio path Uu.

The lower part of Figure 2A describes the essential functions of the radio receiver. The radio receiver is typically a RAKE receiver. An analogous radio frequency signal is received from the radio path Uu with an antenna 234. The signal is forwarded to radio frequency parts 232 comprising a filter which prevents all frequencies outside the desired bandwidth. After this, the signal is converted in a demodulator 230 to an intermediate frequency or directly to a base band, and the thus converted signal is then sampled and quantized.

As the signal in question is a multipath propagated signal, the aim is to combine the signal components that propagated via different paths in block 228 which comprises several RAKE fingers of prior art. The signal components received at different time delays by the RAKE fingers are searched for by correlating the received signal with the spreading codes used and delayed by predefined time delays. When the time delays of the signal components have been found, the signal components belonging to the same signal are combined. At the same time, the spreading of the signal components is removed by multiplying the signal by the spreading code of the physical channel. The interleaving of the received physical channel is then removed in deinterleaving means 226.

The deinterleaved physical channel is then distributed to the data streams of various channels in a demultiplexer 224. The channels are directed each to its own channel decoding block 222A, 222B where the channel coding, for instance block coding or convolution coding, used in transmission is decoded. Convolution coding is preferably decoded with a Viterbi decoder. Each transmitted channel 220A, 220B can then be forwarded to a required further processing, for instance data 220 is forwarded to a computer 122 connected to the user equipment UE. The control channels of the system are forwarded to the control part 236 of the radio receiver.

Figure 2B describes in greater detail the spreading of a channel with a spreading code and its modulation. In the figure, the bit stream of the channel arrives from the left to block S/P in which each two-bit sequence is converted from serial mode to parallel mode, i.e. one bit is forwarded to the I branch of the signal and the second bit to the Q branch. Then the I and Q branches of the signal are multiplied by the same spreading code C_{ch}, in which case the relatively narrowband information is spread on a wide frequency band. Each link Uu has its own spreading code by which the receiver identifies transmissions meant for it. The signal is then scrambled by multiplying it by a scrambling code C_{scramb} which is different for each transmitter. The pulse format of the obtained signal is filtered with a filter p(t). Finally, the signal is modulated to a radio frequency carrier by multiplying its different branches offset by 90 degrees from each other, the thus obtained branches are combined into one carrier which is ready to be transmitted to the radio path Uu apart from possible filtering and power amplifications. The described modulation method is QPSK (Quadrature Phase Shift Keying).

Figure 4A describes different spreading codes. Each point 400 represents one possible spreading code. The vertical dashed lines illustrate different spreading factors SF=1, SF=2, SF=4, SF=8, SF=16, SF=32, SF=64, SF=128, SF=256. The codes on each vertical dashed line are mutually orthogonal. It is thus possible to simultaneously use at most two hundred and fifty six different mutually orthogonal spreading codes. For instance in UMTS, when using a five-megahertz carrier at 4.096 megachips per second, a spreading factor of SF=256 corresponds to a transmission rate of thirty two kilobits per second, and correspondingly the highest practical transmission rate is achieved with spreading factor SF=4, with which the data transmission rate is two thousand forty eight kilobits per second. The transmission rate in the channel varies thus step by step, 32, 64, 128, 256, 512, 1024, and 2048 kbit/s, while the spreading factor changes correspondingly, 256, 128, 64, 32, 16, 8, and 4. The data transmission rate available to the user depends on the channel coding used. For instance, when using 1/3 convolution coding, the data transmission rate of the user is approximately one third of the data transmission rate of the channel. The spreading factor indicates the length of the spreading code. For instance, the spreading code corresponding to spreading factor SF=1 is (1). Spreading factor SF=2 has two mutually orthogonal spreading codes (1,1) and (1,-1). Further, spreading code SF=4

has four mutually orthogonal spreading codes: under the higher-level spreading code (1,1), there are spreading codes (1,1,1,1) and (1,1,-1,-1), and under the second higher-level spreading code (1,-1), there are spreading codes (1,-1,1,-1) and (1,-1,-1,1). The formation of spreading codes is thus continued towards the lower levels of the code tree. The spreading codes of a certain level are always mutually orthogonal. Similarly, a spreading code of a certain level is orthogonal with all lower-level spreading codes derived from another spreading code on the same level.

With reference to Figure 3, an example will be described as to what kind of frame structure can be used in a physical channel. Frames 340A, 340B, 340C, 340D are numbered sequentially from one to seventy two and they form a 720-millisecond long super frame. The length of one frame 340C is 10 milliseconds. Frame 340C is divided into sixteen slots 330A, 330B, 330C, 330D. The length of one slot 330C is 0.625 milliseconds. One slot 330C typically corresponds to one power adjustment period during which power is adjusted one decibel up or down, for instance.

Physical channels are divided into two different types: dedicated physical data channels (DPDCH) 310 and dedicated physical control channels (DPCCH) 312. Dedicated physical data channels 310 are used to transmit data 306 which is generated on the second layer and above of OSI (Open Systems Interconnection), i.e. closest to the dedicated traffic channels. Dedicated physical control channels 312 transmit control information generated on the first layer of OSI. Control information comprises pilot bits 300 used in channel estimation, transmit power control commands (TPC) 302, and optionally a transport format indicator (TFI) 304. The transport format indicator 304 indicates to the receiver the transmission rate used for each dedicated physical data channel of the uplink at a given time.

As shown in Figure 3, the dedicated physical data channels 310 and the dedicated physical control channels 312 on the downlink are time-multiplexed to the same slot 330C. However, on the uplink, the channels in question are transmitted parallel so that they are IQ/code-multiplexed (I=in-phase, Q=quadrature) to each frame 340C and transmitted using dual-channel QPSK modulation (dual-channel quadrature phase-shift keying modulation). When additional dedicated physical data channels 310 need to be transmitted, they are code-multiplexed to the I or Q branch of the first channel pair.

If necessary, an associated control channel can be multiplexed to a dedicated physical data channel, in which associated control channel the control data of the second and higher layers is transmitted, e.g. update data on active sets and adjustment of signal/interference target of the outer power control loop. This multiplexing causes a problem with capacity as described in the beginning.

When using spreading factor SF=256, for instance, there are ten symbols available for use, i.e. twenty bits for slot 330C. This makes 320 bits per frame. The use of these bits is distributed as shown in table 1, for instance.

Content	Length
DPCCH: PILOT	32 symbols = 64 bits
DPCCH: TPC	8 symbols = 16 bits
DPCCH: TFI	8 symbols = 16 bits
DPDCH: DATA	112 symbols = 224 bits

Table 1

Thus there are 224 bits left for user data. For instance, to transmit speech data to a normal speech codec at eight kilobits per second, 80 of the above bits are needed for data, 16 for cyclic redundancy check and 8 as tail bits, i.e. altogether 104 bits. The coding ratio obtained for the convolution coding to be used is 104/224 = 0.46, and this does not yet include the approximately twenty bits needed by the associated control channel. The convolution coding to be used is thus already worse than 1/2 convolution coding. In such a channel, it is difficult to transmit the bits needed by the associated control channel, because the amount of channel coding is quite small and because it is necessary to use puncturing, i.e. elimination coding.

The situation becomes even worse, if it is necessary to transmit speech data to an enhanced speech codec, i.e. at a rate of 12.2 kbit/s. Then the coding ratio is only 0.60 (= 224 data bits + 16 CRC bits + 8 tail bits divided by 448).

The method of the invention for transmitting data from the radio network subsystem RNS over the radio link Uu to the user equipment UE can be described with the flowcharts in Figures 6A and 6B. The execution of the

method for an individual radio frame is started in block 600.

In blocks 604 and 606, the radio network subsystem RNS transmits a dedicated physical channel to the user equipment UE. As described above, the dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel. As also described above, the dedicated physical channel is formed by frames to be transmitted to the radio link Uu.

In blocks 608 and 610, the radio network subsystem RNS spreads each channel with a spreading code during transmission. The length of the spreading code, i.e. spreading factor, determines the transmission rate, and a spreading code to be used in normal situation is reserved for the radio link Uu. The spreading factor of this normal spreading code can be 256, for instance.

Block 602 describes the basic idea of the invention, i.e. that in a special situation, at least one frame of a dedicated physical data channel is spread with a shared spreading code. The shared spreading code in question is shorter than the spreading code used in normal situations. In addition, the shared spreading code in question is shared by time division between the dedicated physical data channels of at least two different the radio links Uu. The spreading factor of the spreading code used in special situations can be 128, for instance.

Figure 6B shows in greater detail the operation executed in block 602 of Figure 6A. The execution of the sub-block is started from block 620. Then, in block 622, a check is made to see if this is a special situation, i.e. is more than the usual amount of data transmission capacity needed for the dedicated physical data channel. If the need for data transmission capacity is as usual, i.e. it can be satisfied with the spreading code used in normal situations, execution continues from block 624.

In block 624, a check is made to see if a normal spreading code has already been allocated to the radio link Uu in question. If a code has not been allocated, execution continues from block 628 where a code is allocated and it is used to spread the frame being processed. If a code has already been allocated, execution continues from block 630 where the allocated spreading code is used to spread the frame.

If the need for data transmission capacity was higher than usual in block 622, execution is continued from block 626. In block 626, a check is made to see if any one of the already allocated shared spreading codes has

any free capacity. If none of the shared spreading codes have any free capacity, a new shared spreading code is selected in block 632 with a spreading factor smaller than that of the normally used spreading code, and the selected shared spreading code is used to spread the frame being processed. If one of the shared spreading codes has free capacity, the shared spreading code in question is used in block 634 to spread the frame being processed.

In the method, "normal situation" refers to a situation in which the spreading code allocated for the radio link can be used. Correspondingly, a "special situation" is one in which the data transmission capacity of the spreading code allocated for the radio link is not enough to transmit the required data. The spreading factor of a spreading code used in normal situations can be 256, for instance, and the spreading factor of a spreading code use in special situations 128, for instance. These numerical values are only examples, i.e. other kind of value combinations are also possible.

A special situation can be caused by the situation described above, in which an associated control channel is needed to be multiplexed to a dedicated physical data channel. Another example of a special situation is when the user equipment UE functions in slotted mode. In such a case, the user equipment UE measures the received power of other frequencies of adjacent base transceiver stations B for part of the duration of the radio frame transmitted normally by the radio network subsystem RNS. Such cells operating on different frequencies can occur in environments with both outdoor and indoor cells, for instance. Thus, the user equipment cannot receive the frame in question and the information it contains would be lost during normal operation. According to the invention, this is a special situation and during the rest of the duration of the frame, the radio network subsystem RNS transmits a shortened frame using a shared spreading code to spread it. Even though the frame is shortened, it can transmit the same quantity of data as in a normal frame thanks to the shared spreading code used. The data transmission capacity of a shared spreading code is higher than that of a normally used spreading code.

Let us then examine Figure 4B which shows how codes can be reserved from the code tree in Figure 4A to be used according to the method of the invention. It is assumed in Figure 4B that the spreading factor of a spreading code used in normal situations is SF=256, and the spreading factor

of a spreading code used in special situations is half of it, i.e. SF=128. The basic principle for sharing codes is that the spreading code reserved for the radio link Uu to be used in normal situations and the shared spreading code to be used in special situations reside on different levels and in different branches of the code tree. Generally, it can be said that if Y users share one spreading code, the spreading factor of which is SF=128, X spreading codes with spreading factor SF=256 remain for use:

$$X + 2(X/Y) = 256 \quad (1)$$

X can be obtained from Formula 1:

$$X = 256 / (1+2/Y) \quad (2)$$

Formula 2 can then be used to calculate values of X by substituting Y with different figures:

If Y=4, then X=170, i.e. if four users share one shared spreading code with spreading factor 128, then 170 spreading codes with spreading factor 256 remain free.

If Y=6, then X=192, i.e. if six users share one shared spreading code with spreading factor 128, then 192 spreading codes with spreading factor 256 remain free.

If Y=8, then X=204, i.e. if eight users share one shared spreading code with spreading factor 128, then 204 spreading codes with spreading factor 256 remain free.

The example of Figure 4B describes the middle alternative, i.e. it is assumed in the example that six radio links share the same shared spreading code.

Figure 4B illustrates normal spreading codes by means of indexes, which start with SF=256, i.e. spreading codes SF=256, CODE1, SD=256, CODE2, etc. These codes reserve the first 96 of the codes of spreading level SF=128. The shared spreading codes shared between six users are thus codes of spreading level SF=128: SF=128, CODE97, SF=128, CODE 98, etc. Altogether 192 codes of spreading level SF=256 and 32 shared codes of spreading level SF=128 are thus in use.

With the method of the invention, it is thus possible to support the

simultaneous use of as many as 192 orthogonal spreading codes, for instance to transmit speech or some other circuit-switched service, while fulfilling any requirements set by special situations. This provides a high increase of 50% in resources as opposed to prior art solutions in which only 128 orthogonal spreading codes can be simultaneously used without problems taking special situations into account.

Figures 7A and 7B are examined next. They illustrate how the spreading codes described in the example in Figure 4B are shared between radio links. In the example in Figure 7A, it is assumed that the frames of different radio links are not synchronized, i.e. their transmission times have not been synchronized with each other to transmit the frames at the same moment of time. Therefore, the radio link Uu receives a shared spreading code for use for a time period which is twice the length of the frame to be transmitted to the radio link Uu. Figure 7A shows in vertical direction the timing used for the radio links Uu of six user equipment UE1, UE2, UE3, UE4, UE5, UE6. The horizontal direction shows how ten-millisecond long radio frames numbered #1, #2, ..., #72 are transmitted consecutively to each user equipment. The lowest line segment shows the time slots of high data transmission capacity SLOT1, SLOT2, ..., SLOT6. One high data transmission slot is twice the length of a normal frame, i.e. twenty milliseconds. One after the other, each time slot now receives one high data transmission capacity slot for use. As six radio links share the spreading code of high data transmission capacity in question, each radio link can use the shared spreading code in question at hundred-millisecond intervals for twenty milliseconds at a time. In Figure 7A, a black frame marks the time slots of the radio link of each user equipment during which the user equipment in question can use the shared spreading code. In other words, user equipment UE1, for instance, can always use the first time slot SLOT1 of the shared spreading code. In which of its ten-millisecond frames the user equipment UE1 can use the shared spreading code is entirely dependent on the timing of the user equipment in question. The user equipment UE1 transmits frames #1, #13 using the shared spreading code. Correspondingly, the user equipment UE4, for instance, uses the fourth time slot SLOT4 of the shared spreading code and sends frames #7, #19, #31, #43, #55, and #67, for instance, using the shared spreading code, if necessary.

Figure 7B shows an enlarged detail of Figure 7A outlined in Figure

7A with a dashed line and marked with reference "FIG 7B". Figure 7B illustrates how three frames FRAME #6, FRAME #7, and FRAME #8 of the fourth user equipment UE4 are spread. In the normally transmitted frames FRAME #6 and FRAME #9, both the dedicated physical control channel and the dedicated physical data channel are spread using the spreading code, the spreading factor of which is SF=256, allocated to the link for normal situations. According to the invention, the dedicated physical data channel of the frame FRAME #7 is spread using the shared spreading code, the spreading factor of which is SF=128. There are two different possibilities for spreading the dedicated physical control channel of the frame FRAME #7: either the same shared spreading code is used as for spreading the dedicated physical data channel, or the spreading code for normal situations is used.

The example in Figure 7A illustrated a case in which frames of different radio links were not synchronized with each other. When the frames of different radio links Uu are synchronized with each other, each radio link Uu receives the shared spreading code for use for a time period which is the same length as the frame to be transmitted to the radio link Uu. In this case, each user equipment can use the shared spreading code at intervals of fifty milliseconds.

In a preferred embodiment, each radio link Uu receives the shared spreading code for use when necessary. In comparison with the example in Figure 7A, in which each radio link Uu receives the shared spreading code for use as frames agreed in advance by the radio network subsystem RNS and the user equipment UE, this provides the advantage that the shared code resource is not kept reserved in vain, but the disadvantage in this is that more signalling is required.

In a preferred embodiment, the dedicated physical control channel comprises a transport format indicator TFI which indicates the spreading code used to spread the dedicated physical data channel. This can be implemented in at least two different ways: 1) the transport format indicator in the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame, 2) the transport format indicator in the physical frame preceding the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame. In alternative 1, the signalling does not have a delay of ten milliseconds as is the case in alternative 2. On the other hand, alternative 2

does not require duplication of the parts removing the spreading in the receiver as is the case in alternative 1.

The method of the invention can also be used in a situation where the user equipment UE is performing a soft handover. In a soft handover, at least two different base transceiver stations B transmit to the user equipment UE a dedicated physical data channel using a shared spreading code of equal length for spreading so that the user equipment UE receives the transmissions in question substantially at the same moment. The shared spreading code used is selected independently for each base transceiver station B, i.e. it does not have to be the same as long as the length of the spreading code used is the same, i.e. they have the same spreading factor. Timing need not be the same and it is, in practice, enough that for instance the symbols transmitted via different radio paths to the user equipment UE overlap partly. For example, when using a five-megahertz carrier at 4.096 megachips per second, it is possible to send 160 symbols per one ten-millisecond frame channel-coded with a spreading code, the spreading factor of which is 256. Thus, the chips of symbols corresponding to each other need not be exactly on top of each other, but an offset of 50 to 100 chips, for instance, is allowed. The offset can also be larger, but then the processing required is more complex.

The invention is preferably implemented by means of software. The processing required in the radio network subsystem necessitates changes in the protocol processing software and in the control of transmitter operation, in particular the processing of spreading codes. Correspondingly, it is necessary to make changes in the protocol processing software and in the control of receiver operation, in particular the processing of spreading codes, of the user equipment.

Even though the invention has been explained in the above with reference to examples in accordance with the accompanying drawings, it is obvious that the invention is not restricted to them but can be modified in many ways within the scope of the inventive idea disclosed in the attached claims.

CLAIMS

1. A method for transmitting data from a radio network subsystem (RNS) over a radio link (Uu) to user equipment (UE) in a mobile telephone system, which comprises:

- (604, 606) the radio network subsystem (RNS) transmits a dedicated physical channel to the user equipment (UE), which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and the dedicated physical channel is formed by frames to be transmitted to the radio link (Uu);

- (608, 610) during transmission, the radio network subsystem (RNS) spreads each channel with a spreading code, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and a spreading code to be used in normal situations is reserved for the radio link (Uu),

characterized in that (602) in a special situation at least one frame of the dedicated physical data channel is spread with a shared spreading code, which shared spreading code is shorter than the spreading code used in normal situations, and the shared spreading code in question is shared by time division between the dedicated physical data channels of at least two different radio links (Uu).

2. A method as claimed in claim 1, **characterized** in that an associated control channel is multiplexed to the dedicated physical data channel in special situations.

3. A method as claimed in claim 1, **characterized** in that in special situations the user equipment (UE) functions in slotted mode, in which the user equipment (UE) measures the received power of other frequencies of adjacent base transceiver stations (B) for part of the duration of the frame transmitted normally by the radio network subsystem (RNS), and during the rest of the duration of the frame, the radio network subsystem (RNS) transmits a shortened frame using a shared spreading code to spread it.

4. A method as claimed in claim 1, **characterized** in that when the frames of different radio links (Uu) are not synchronized with each other, each radio link (Uu) receives a shared spreading code for use for a time period which is twice the length of the frame to be transmitted to the radio link (Uu).

5. A method as claimed in claim 1, **characterized** in that when the frames of different radio links (Uu) are synchronized with each other, each radio link (Uu) receives a shared spreading code for use for a time period which is the same length as the frame to be transmitted to the radio link Uu.

6. A method as claimed in claim 1, **characterized** in that the dedicated physical control channel is spread with a shared spreading code.

7. A method as claimed in claim 1, **characterized** in that each radio link (Uu) receives a shared spreading code for use as frames agreed in advance by the radio network subsystem (RNS) and the user equipment (UE).

8. A method as claimed in claim 1, **characterized** in that each radio link (Uu) receives a shared spreading code for use when necessary.

9. A method as claimed in claim 1, **characterized** in that the dedicated physical control channel comprises a transport format indicator which indicates the spreading code used to spread the dedicated physical data channel.

10. A method as claimed in claim 9, **characterized** in that the transport format indicator in the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame.

11. A method as claimed in claim 9, **characterized** in that the transport format indicator in the physical frame preceding the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame.

12. A method as claimed in claim 1, **characterized** in that the spreading codes are arranged into a code tree in such a manner that the first level of the code tree root comprises a one-bit spreading code, the second level comprises two branches with mutually orthogonal two-bit spreading codes, the third level comprises four branches with mutually orthogonal four-bit spreading codes, the fourth level comprises eight branches with mutually orthogonal eight-bit spreading codes, the fifth level comprises sixteen branches with mutually orthogonal sixteen-bit spreading codes, the sixth level comprises thirty two branches with mutually orthogonal thirty-two-bit spreading codes, the seventh level comprises sixty four branches with mutually

orthogonal sixty-four-bit spreading codes, the eight level comprises one hundred and twenty eight branches with mutually orthogonal 128-bit spreading codes, the ninth level comprises two hundred and fifty six branches with mutually orthogonal 256-bit spreading codes, and an unambiguous method to refer to a spreading code has been agreed on by the radio network subsystem (RNS) and the user equipment (UE).

13. A method as claimed in claim 12, **characterized** in that the transmission rate is altered by changing the length of the spreading code used to spread a frame, i.e. by moving from one level to another in the code tree.

14. A method as claimed in claim 12, **characterized** in that the spreading code reserved for the radio link (Uu) to be used in normal situations and the shared spreading code to be used in special situations reside on different levels and in different branches of the code tree.

15. A method as claimed in claim1, **characterized** in that in a soft handover at least two different base transceiver stations (B) transmit to the user equipment (UE) a dedicated physical data channel using a shared spreading code of equal length for spreading so that the user equipment (UE) receives the transmissions in question substantially at the same moment.

16. A radio network subsystem (RNS) which is adapted:

- to transmit a dedicated physical channel over a radio link (Uu) to the user equipment (UE), which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and to form a dedicated physical channel from the frames to be transmitted to the radio link (Uu);

- to spread each channel with a spreading code during transmission, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and to reserve a spreading code to be used in normal situations for the radio link (Uu).

characterized in that the subsystem is adapted to spread in a special situation at least one frame of the dedicated physical data channel with a shared spreading code which is shorter than the spreading code used in normal situations, and to share the shared spreading code in question by time division between the dedicated physical data channels of at least two different radio links (Uu).

17. A radio network subsystem as claimed in claim 16, **characterized** in that in special situations the radio network subsystem (RNS) is adapted to multiplex an associated control channel to the dedicated physical data channel.

18. A radio network subsystem as claimed in claim 16, **characterized** in that in special situations the user equipment (UE) functions in slotted mode, in which the user equipment (UE) measures the received power of other frequencies of adjacent base transceiver stations (B) for part of the duration of the frame transmitted normally by the radio network subsystem (RNS), and during the rest of the duration of the frame, the radio network subsystem (RNS) is adapted to transmit a shortened frame using a shared spreading code to spread it.

19. A radio network subsystem as claimed in claim 16, **characterized** in that when the frames of different radio links (Uu) are not synchronized with each other, the radio network subsystem (RNS) is adapted to provide each radio link (Uu) with a shared spreading code for use for a time period which is twice the length of the frame to be transmitted to the radio link (Uu).

20. A radio network subsystem as claimed in claim 16, **characterized** in that when the frames of different radio links (Uu) are synchronized with each other, the radio network subsystem (RNS) is adapted to provide each radio link (Uu) with a shared spreading code for use for a time period which is the same length as the frame to be transmitted to the radio link Uu.

21. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to spread a dedicated physical control channel with a shared spreading code.

22. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to provide each radio link (Uu) with a shared spreading code as frames agreed in advance by the radio network subsystem (RNS) and the user equipment (UE).

23. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to provide each radio link (Uu) with a shared spreading code when necessary.

24. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to

place into the dedicated physical control channel a transport format indicator which indicates the spreading code used to spread the dedicated physical data channel.

25. A radio network subsystem as claimed in claim 24, **characterized** in that the radio network subsystem (RNS) is adapted to place into the transport format indicator of the physical frame to be transmitted the identification data of the spreading code used to spread the dedicated physical data channel in the frame to be transmitted.

26. A radio network subsystem as claimed in claim 24, **characterized** in that the radio network subsystem (RNS) is adapted to place into the transport format indicator of the physical frame preceding the physical frame to be transmitted the identification data of the spreading code used to spread the dedicated physical data channel in the frame to be transmitted.

27. A radio network subsystem as claimed in claim 16, **characterized** in that the spreading codes are arranged into a code tree in such a manner that the first level of the code tree root comprises a one-bit spreading code, the second level comprises two branches with mutually orthogonal two-bit spreading codes, the third level comprises four branches with mutually orthogonal four-bit spreading codes, the fourth level comprises eight branches with mutually orthogonal eight-bit spreading codes, the fifth level comprises sixteen branches with mutually orthogonal sixteen-bit spreading codes, the sixth level comprises thirty two branches with mutually orthogonal thirty-two-bit spreading codes, the seventh level comprises sixty four branches with mutually orthogonal sixty-four-bit spreading codes, the eight level comprises one hundred and twenty eight branches with mutually orthogonal 128-bit spreading codes, the ninth level comprises two hundred and fifty six branches with mutually orthogonal 256-bit spreading codes, and an unambiguous method to refer to a spreading code has been agreed on by the radio network subsystem (RNS) and the user equipment (UE).

28. A radio network subsystem as claimed in claim 27, **characterized** in that the radio network subsystem (RNS) is adapted to alter the transmission rate by changing the length of the spreading code used to spread a frame, i.e. by moving from one level to another in the code tree.

29. A radio network subsystem as claimed in claim 27, **characterized** in that the radio network subsystem (RNS) is adapted to

reserve for the radio link (Uu) from different levels and branches of the code tree a spreading code for use in normal situations and a shared spreading code for special situations.

30. A radio network subsystem as claimed in claim 16, **characterized** in that in a soft handover, the radio network subsystem (RNS) is adapted to transmit a dedicated physical data channel to the user equipment (UE) through at least two different base transceiver stations (B) using a shared spreading code of equal length for spreading so that the user equipment (UE) receives the transmissions in question substantially at the same moment.

31. User equipment (UE) which is adapted:

- to receive a dedicated physical channel transmitted by the radio network subsystem (RNS) over a radio link (Uu), which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and to form a dedicated physical channel from the frames to be received from the radio link (Uu);

- to remove during reception the spreading of each channel with a spreading code, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and to use in normal situations the spreading code reserved for the radio link (Uu) for normal situations to remove the spreading,

characterized in that in special situations, the user equipment is adapted to remove the spreading of at least one frame of the dedicated physical data channel with a shared spreading code which is shorter than the spreading code used in normal situations and which is used by time division between the dedicated physical data channels of at least two different radio links (Uu).

32. User equipment as claimed in claim 31, **characterized** in that in special situations the user equipment (UE) is adapted to demultiplex an associated control channel from the physical data channel.

33. User equipment as claimed in claim 31, **characterized** in that in special situations the user equipment (UE) is adapted to function in slotted mode, in which the user equipment (UE) measures the received power of other frequencies of adjacent base transceiver stations (B) for part of the duration of the frame transmitted normally by the radio network subsystem (RNS), and during the rest of the duration of the frame, the user equipment

(UE) is adapted to receive a shortened frame transmitted by the radio network subsystem (RNS), and to use the shared spreading code to remove the spreading of the shortened frame in question.

34. User equipment as claimed in claim 31, **characterized** in that when the frames of different radio links (Uu) are not synchronized with each other, the user equipment (UE) is adapted to receive a shared spreading code for use for a time period which is twice the length of the frame to be received from the radio link (Uu).

35. User equipment as claimed in claim 31, **characterized** in that when the frames of different radio links (Uu) are synchronized with each other, the user equipment (UE) is adapted to receive a shared spreading code for use for a time period which is the same length as the frame to be received from the radio link Uu.

36. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to remove the spreading of the dedicated physical control channel with the shared spreading code.

37. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to agree with the radio network subsystem (RNS), in which earlier agreed frames will the shared spreading code be used in a radio link (Uu).

38. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to request from the radio network subsystem (RNS) a shared spreading code for use in a radio link (Uu), when necessary.

39. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to read the spreading code used to spread the dedicated physical data channel from the transport format indicator in the dedicated physical control channel.

40. User equipment as claimed in claim 39, **characterized** in that the user equipment (UE) is adapted to read the identification data of the spreading code used to spread the dedicated physical data channel in the received frame from the transport format indicator in the received physical frame.

41. User equipment as claimed in claim 39, **characterized** in that the user equipment (UE) is adapted to read the identification data of the spreading code used to spread the dedicated physical data channel in the

received frame from the transport format indicator in the physical frame preceding the received physical frame.

42. User equipment as claimed in claim 31, **characterized** in that the spreading codes are arranged into a code tree in such a manner that the first level of the code tree root comprises a one-bit spreading code, the second level comprises two branches with mutually orthogonal two-bit spreading codes, the third level comprises four branches with mutually orthogonal four-bit spreading codes, the fourth level comprises eight branches with mutually orthogonal eight-bit spreading codes, the fifth level comprises sixteen branches with mutually orthogonal sixteen-bit spreading codes, the sixth level comprises thirty two branches with mutually orthogonal thirty-two-bit spreading codes, the seventh level comprises sixty four branches with mutually orthogonal sixty-four-bit spreading codes, the eight level comprises one hundred and twenty eight branches with mutually orthogonal 128-bit spreading codes, the ninth level comprises two hundred and fifty six branches with mutually orthogonal 256-bit spreading codes, and an unambiguous method to refer to a spreading code has been agreed on by the radio network subsystem (RNS) and the user equipment (UE).

43. User equipment as claimed in claim 31, **characterized** in that in a soft handover, the user equipment (UE) is adapted to receive a dedicated physical data channel transmitted through at least two different base transceiver stations (B) substantially at the same moment, and to remove the spreading using a shared spreading code of equal length.

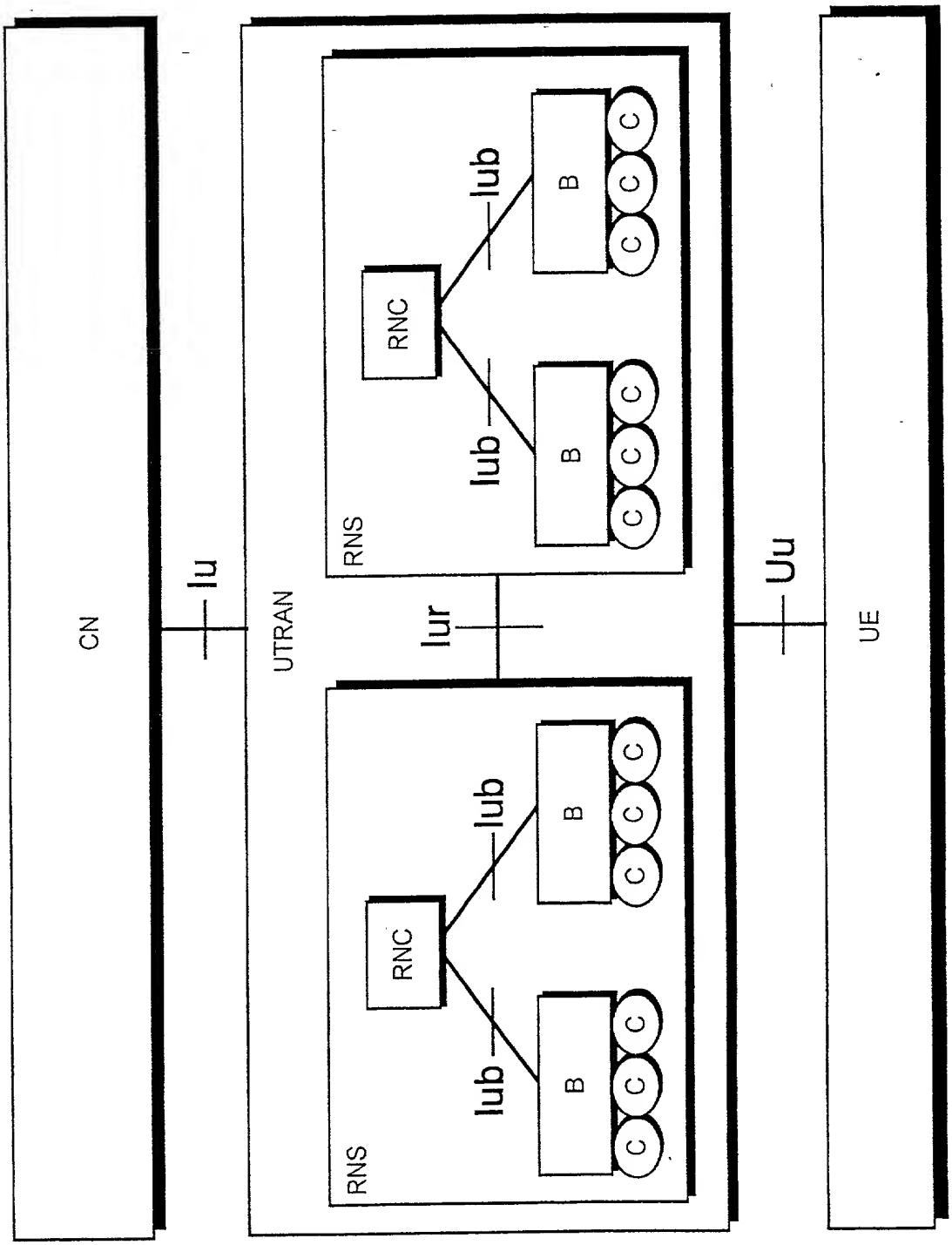

Fig 1A

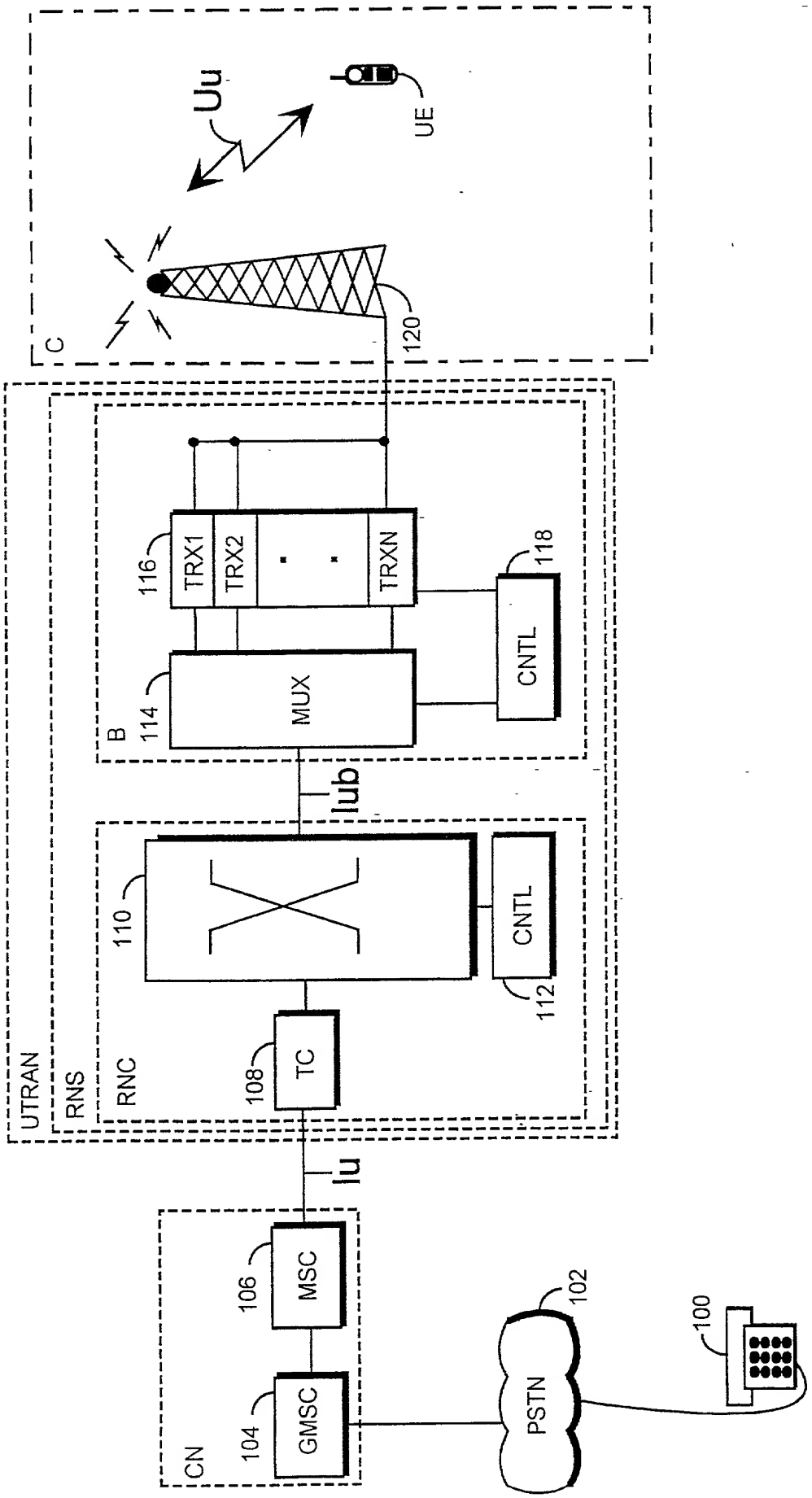
Uu
UE
C
120
B
116
TRX1
TRX2
TRXN
118
CNTL
114
MUX
Iub
110
CNTL
112
RNC
RNS
UTRAN
108
TC
Iu
106
MSC
104
GMSC
CN
PSTN
102
100

Fig 1B

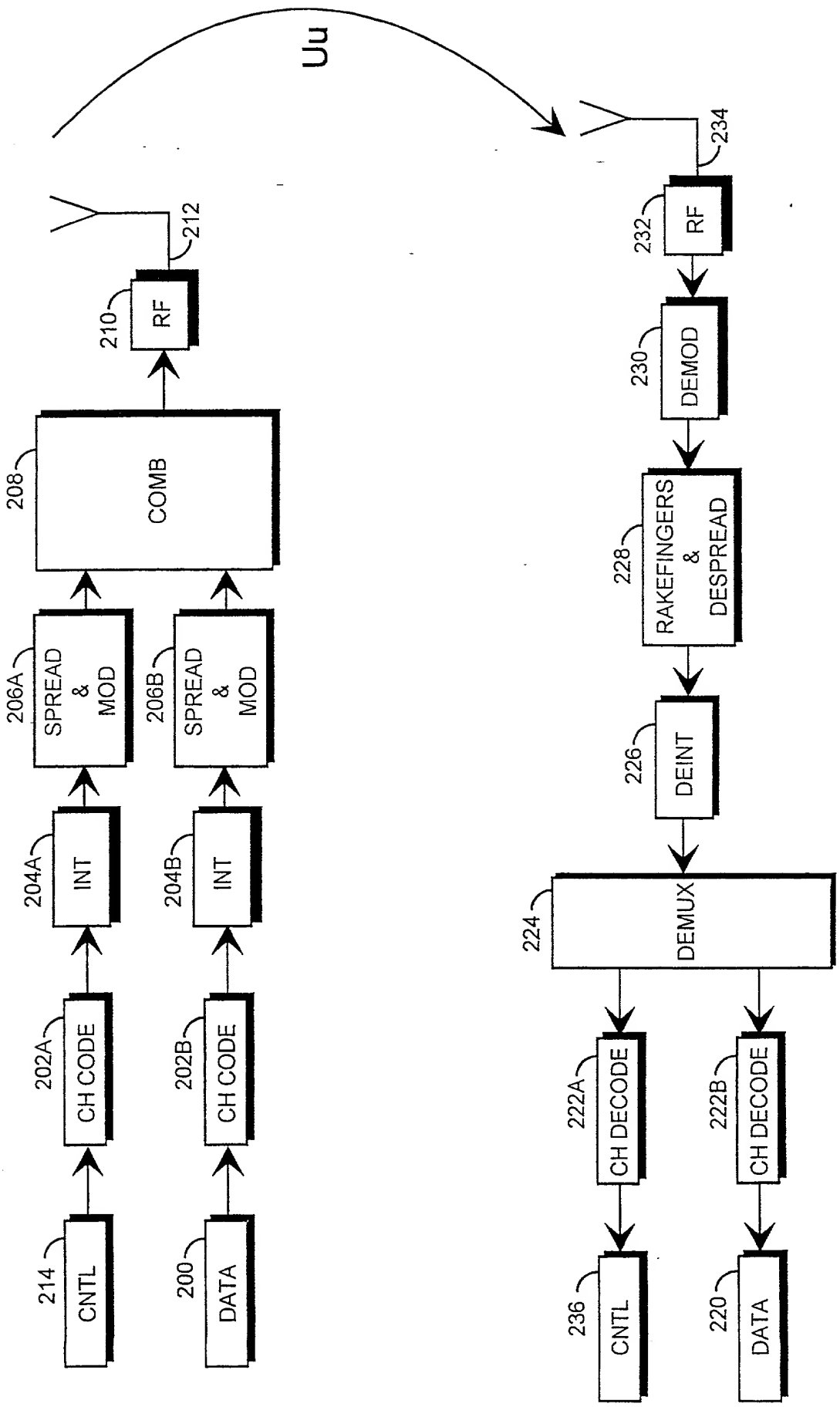
Uu
214
CNTL
200
DATA
202A
CH CODE
202B
CH CODE
204A
INT
204B
INT
206A
SPREAD & MOD
206B
SPREAD & MOD
208
COMB
210
RF
212
232
RF
230
DEMOD
228
RAKEFINGERS & DESPREAD
226
DEINT
224
DEMUX
222A
CH DECODE
222B
CH DECODE
236
CNTL
220
DATA
234

Fig 2A

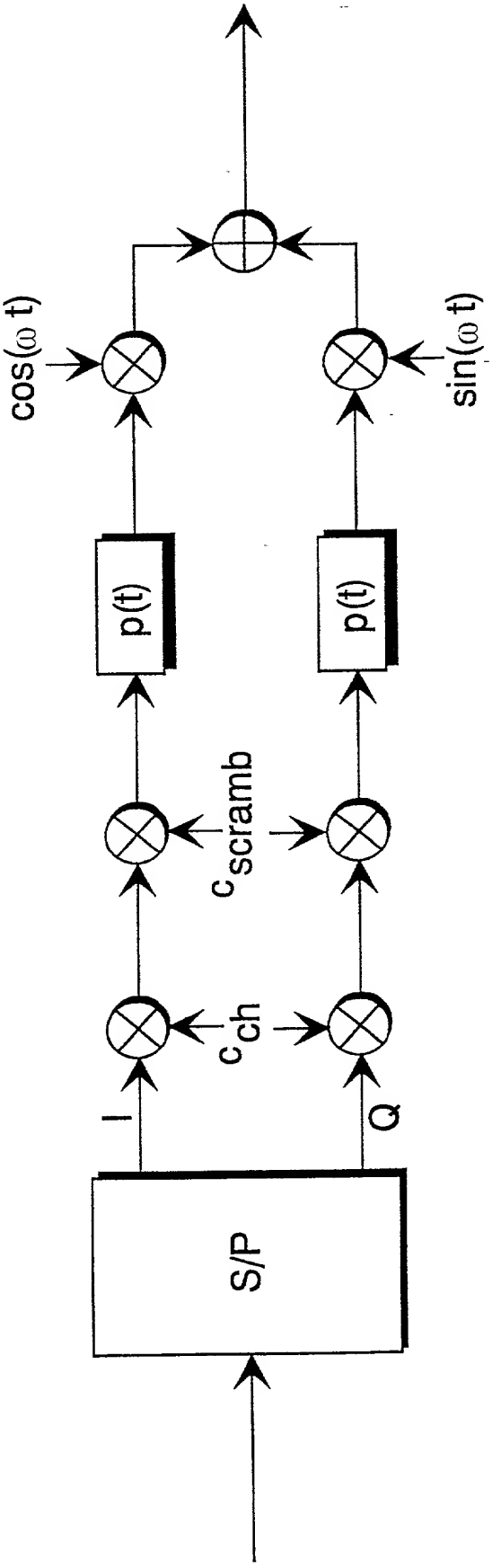
cos(ω t)
sin(ω t)
p(t)
p(t)
c scramb
c ch
I
Q
S/P

Fig 2B

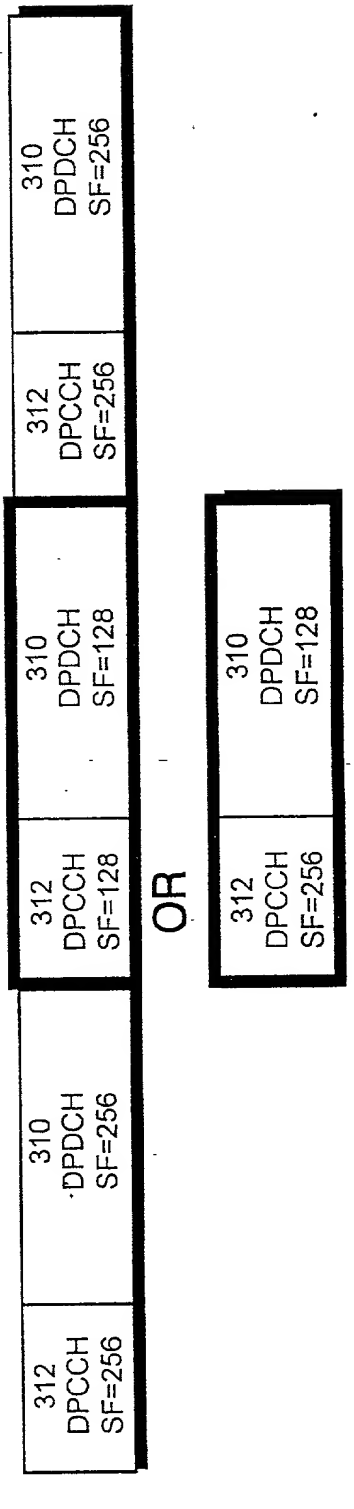
312 DPCCH SF=256
310 DPDCH SF=256
312 DPCCH SF=128
310 DPDCH SF=128
OR
312 DPCCH SF=256
310 DPDCH SF=128
UE4
FRAME #6
FRAME #7
FRAME #8

Fig 7B

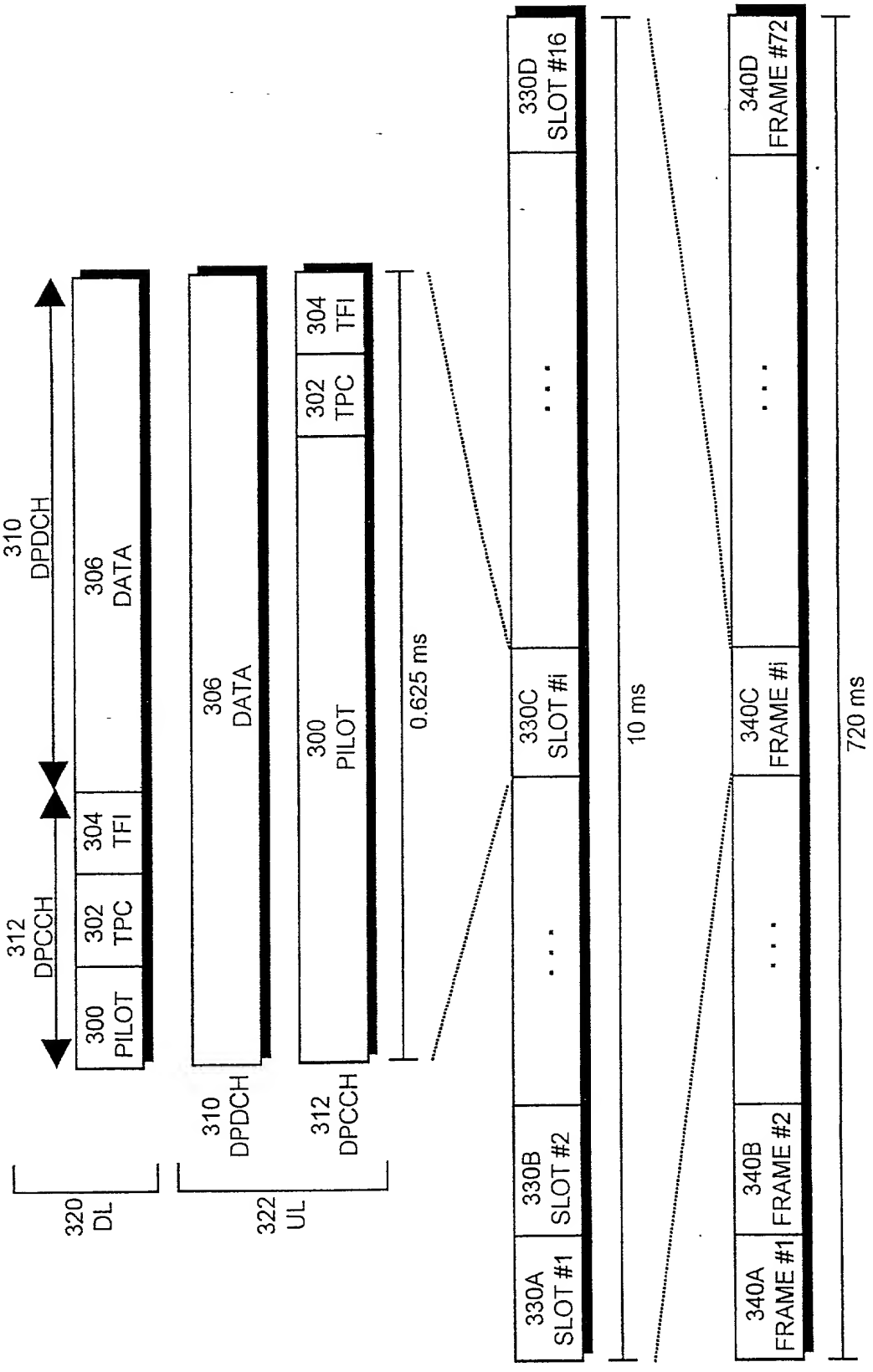
320
DL
322
UL
312
DPCCH
310
DPDCH
300
PILOT
302
TPC
304
TFI
306
DATA
0.625 ms
330A
SLOT #1
330B
SLOT #2
330C
SLOT #i
330D
SLOT #16
10 ms
340A
FRAME #1
340B
FRAME #2
340C
FRAME #i
340D
FRAME #72
720 ms

Fig 3

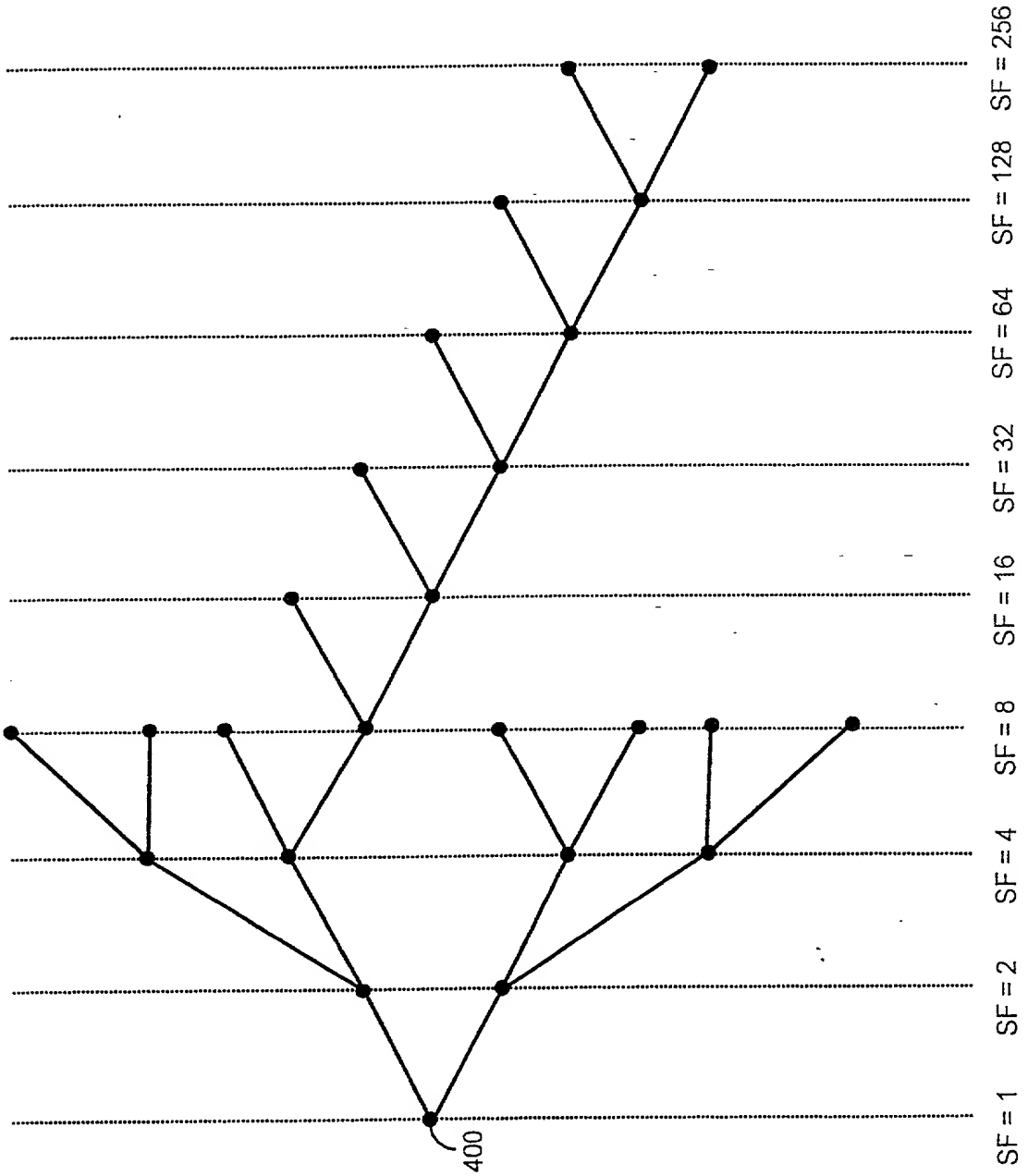

Fig 4A

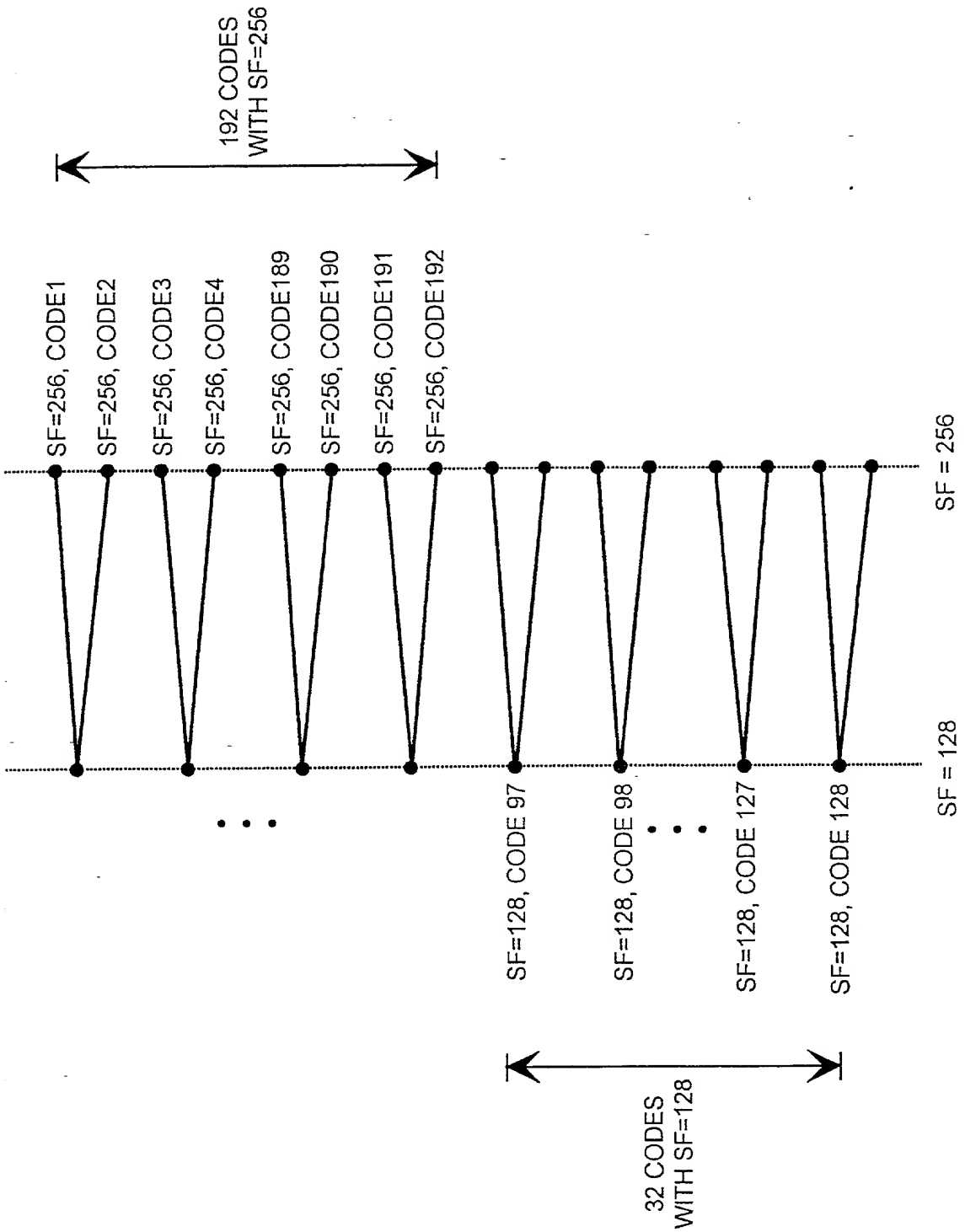
192 CODES
WITH SF=256
SF=256, CODE1
SF=256, CODE2
SF=256, CODE3
SF=256, CODE4
SF=256, CODE189
SF=256, CODE190
SF=256, CODE191
SF=256, CODE192
SF = 256
SF = 128
SF=128, CODE 97
SF=128, CODE 98
SF=128, CODE 127
SF=128, CODE 128
32 CODES
WITH SF=128

Fig 4B

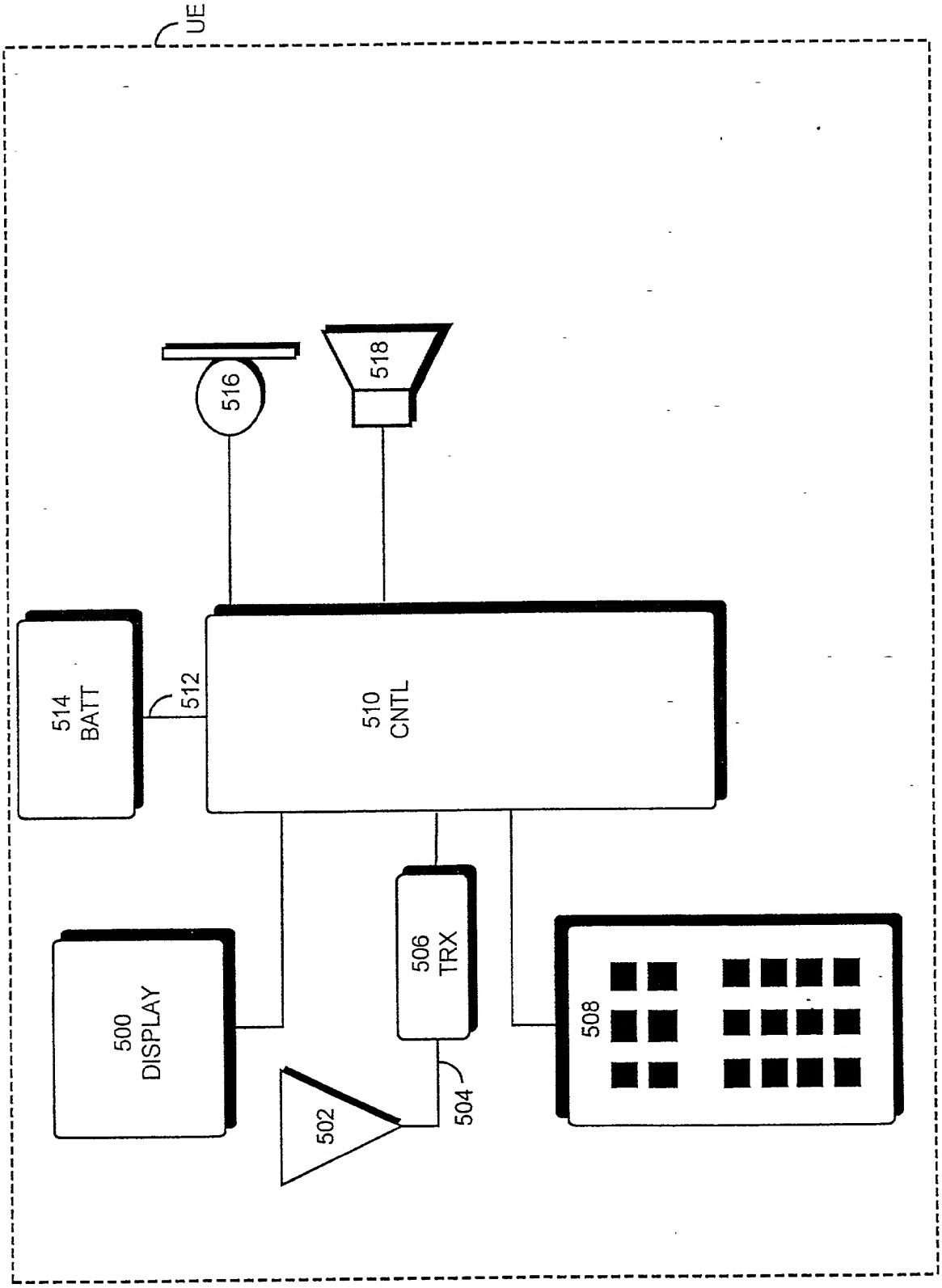
UE
516
518
514
BATT
512
510
CNTL
500
DISPLAY
506
TRX
508
502
504

Fig 5

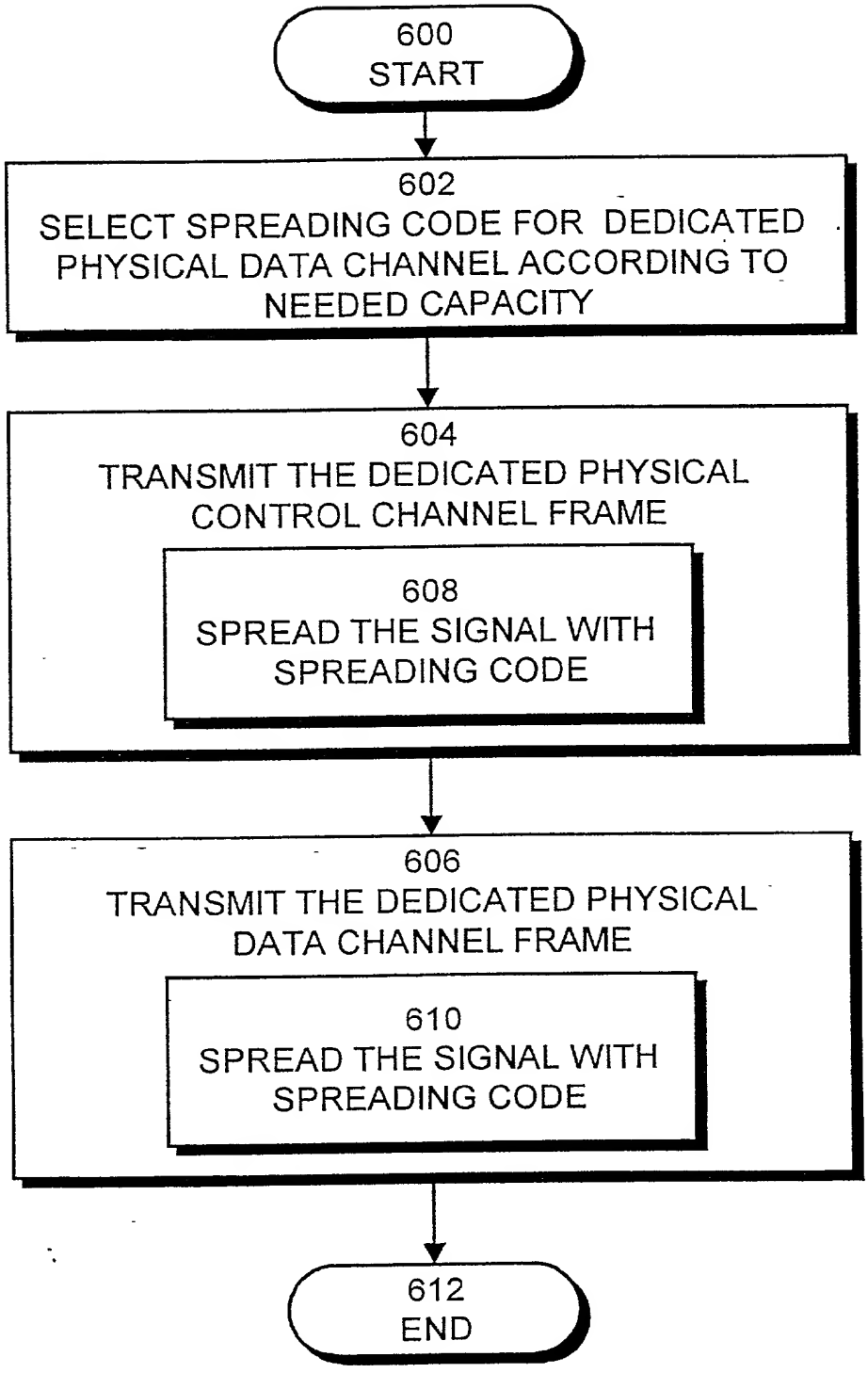
600
START
602
SELECT SPREADING CODE FOR DEDICATED PHYSICAL DATA CHANNEL ACCORDING TO NEEDED CAPACITY
604
TRANSMIT THE DEDICATED PHYSICAL CONTROL CHANNEL FRAME
608
SPREAD THE SIGNAL WITH SPREADING CODE
606
TRANSMIT THE DEDICATED PHYSICAL DATA CHANNEL FRAME
610
SPREAD THE SIGNAL WITH SPREADING CODE
612
END

Fig 6A

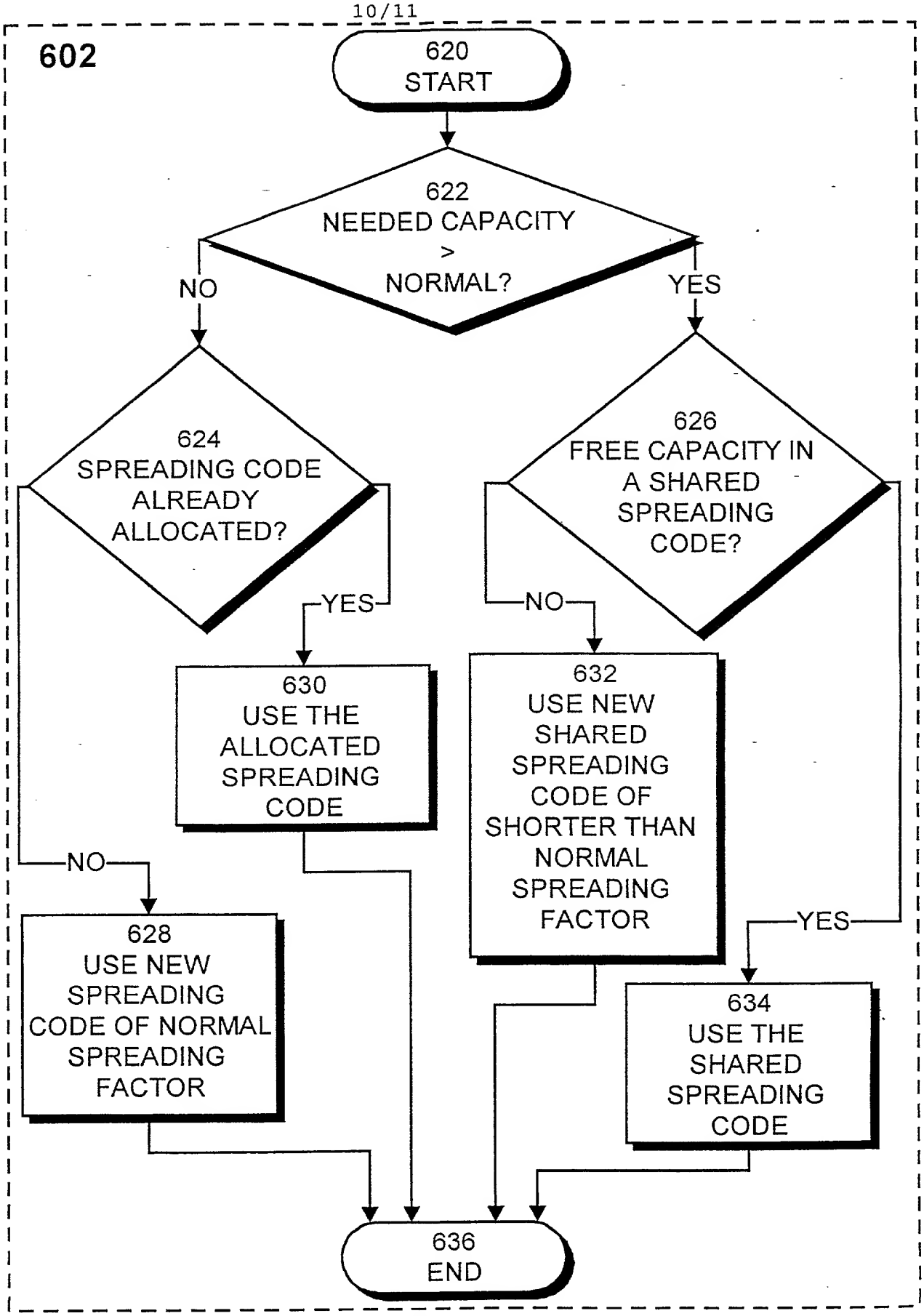
602
620
START
622
NEEDED CAPACITY
>
NORMAL?
NO
YES
624
SPREADING CODE
ALREADY
ALLOCATED?
626
FREE CAPACITY IN
A SHARED
SPREADING
CODE?
YES
NO
630
USE THE
ALLOCATED
SPREADING
CODE
632
USE NEW
SHARED
SPREADING
CODE OF
SHORTER THAN
NORMAL
SPREADING
FACTOR
NO
YES
628
USE NEW
SPREADING
CODE OF NORMAL
SPREADING
FACTOR
634
USE THE
SHARED
SPREADING
CODE
636
END

Fig 6B

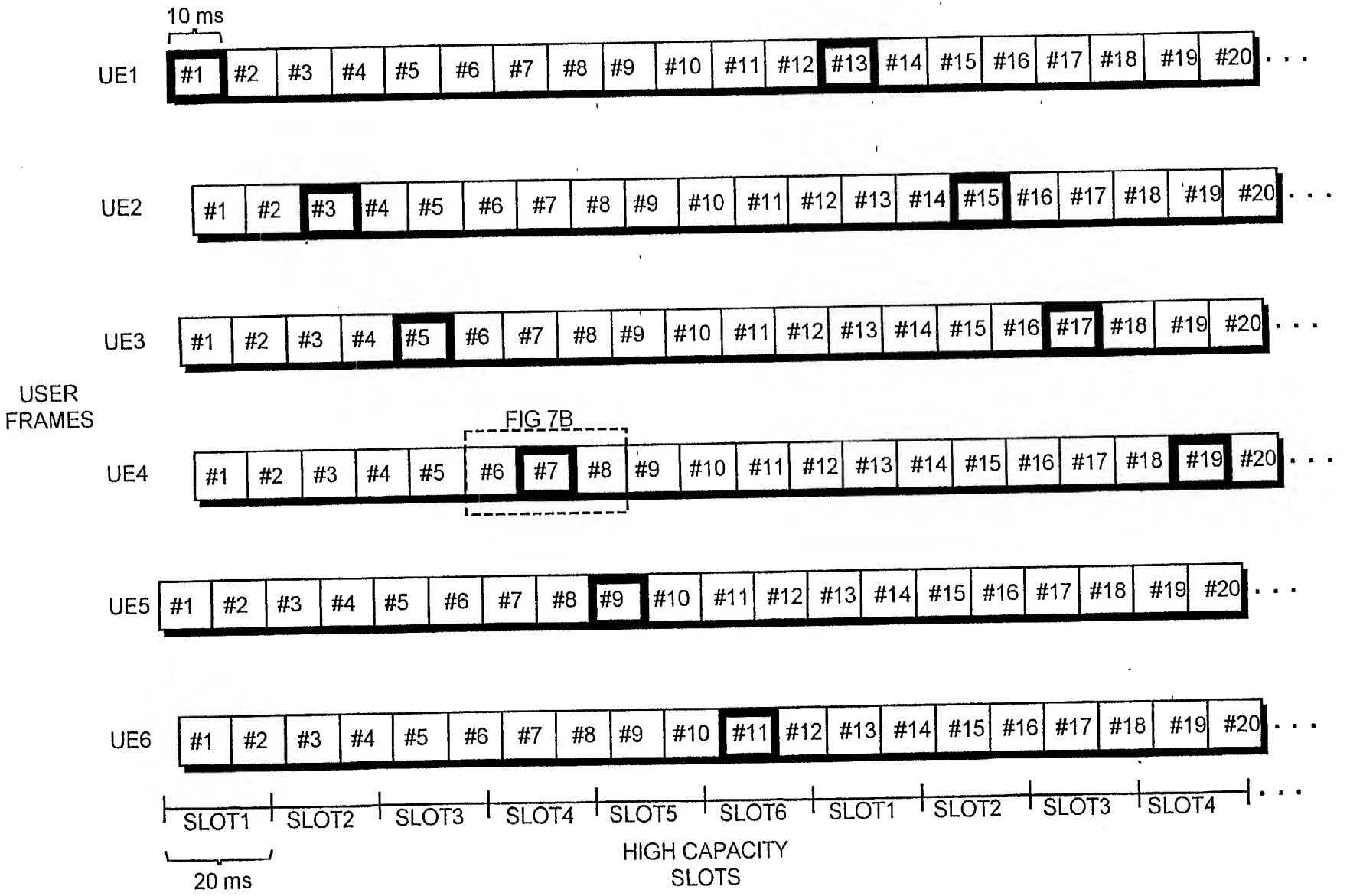
10 ms
UE1
UE2
UE3
USER FRAMES
FIG 7B
UE4
UE5
UE6
#1 #2 #3 #4 #5 #6 #7 #8 #9 #10 #11 #12 #13 #14 #15 #16 #17 #18 #19 #20
SLOT1 SLOT2 SLOT3 SLOT4 SLOT5 SLOT6 SLOT1 SLOT2 SLOT3 SLOT4
20 ms
HIGH CAPACITY SLOTS

Fig 7A

T298060

FOR UTILITY/DESIGN CIP/PCT NATIONAL/PLANT ORIGINAL/SUBSTITUTE/SUPPLEMENTAL DECLARATIONS

RULE 63 (37 C.F.R. 1.63) DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PM & S FORM

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the **INVENTION ENTITLED**

DATA TRANSMISSION METHOD, RADIO NETWORK SUBSYSTEM, AND USER EQUIPMENT

the specification of which (CHECK applicable BOX(ES))

X → A. ☐ is attached hereto.

BOX(ES) → B. ☐ was filed on _____ as U.S. Application No. _____

→ C. X was filed as PCT International Application No. PCT/ FI99 /00635 on 21 July 1999

and (if applicable to U.S. or PCT application) was amended on _____

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose all information known to me to be material to patentability as defined in 37 C F.R. 1.56. Except as noted below, I hereby claim foreign priority benefits under 35 U S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International Application which designated at least one other country than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT International Application, filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date (1) before that of the application on which priority is claimed, or (2) if no priority claimed, before the filing date of this application.

PRIOR FOREIGN APPLICATION(S) Number	Country	Day/MONTH/Year Filed	Date first Laid-open or Published	Date Patented or Granted	Priority NOT Claimed
981649	Finland	22 July 1998			

If more prior foreign applications, X box *at bottom* and continue on attached page.

Except as noted below, I hereby claim domestic priority benefit under 35 U S C 119(e) or 120 and/or 365(c) of the indicated United States applications listed below and PCT international applications listed above or below and, if this is a continuation-in-part (CIP) application, insofar as the subject matter disclosed and claimed in this application is in addition to that disclosed in such prior applications, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in 37 C.F.R. 1.56 which became available between the filing date of each such prior application and the national or PCT international filing date of this application:

PRIOR U.S. PROVISIONAL, NONPROVISIONAL AND/OR PCT APPLICATION(S) Application No. (series code/serial no.)	Day/MONTH/Year Filed	Status pending, abandoned, patented	Priority NOT Claimed

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And I hereby appoint Pillsbury Winthrop LLP, Intellectual Property Group, 1100 New York Avenue, N.W., Ninth Floor, East Tower, Washington, D.C. 20005-3918, telephone number (202) 861-3000 (to whom all communications are to be directed), and the below-named persons (of the same address) individually and collectively my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent, and I hereby authorize them to delete names/numbers below of persons no longer with their firm and to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct the above Firm and/or a below attorney in writing to the contrary.

(27)

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G. Lloyd Knight	17698	Kendrew H. Colton	30368	Richard H. Zaitlen	27248	Robin L. Teskin	35030
Kevin E. Joyce	20508	G. Paul Edgell	24238	Roger R. Wise	31204		
George M. Sirilla	18221	Lynn E. Eccleston	35861	Michael R. Dzwonczyk	36787		
Donald J. Bird	25323	Timothy J. Klima	34852	W. Patrick Bengtsson	32456		
Peter W. Gowdey	25872	David A. Jakopin	32995	Jack S. Barufka	37087		
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(1) **INVENTOR'S SIGNATURE:** Harri Holma **Date:** 15 January 2001

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"X" box ☐ FOR ADDITIONAL INVENTORS, and proceed on the attached page to list each additional inventor.

☐ See additional foreign priorities on attached page (incorporated herein by reference).

Atty. Dkt. No. PM

T298060

Rule 56(a) & (b) = 37 C.F.R. 1.56(a) & (b)
PATENT AND TRADEMARK CASES - RULES OF PRACTICE
DUTY OF DISCLOSURE

(a) ...Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the [Patent and Trademark] Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability...(b) information is material to patentability when it is not cumulative and (1) It also establishes by itself, or in combination with other information, a prima facie case of unpatentability of a claim or (2) refutes, or is inconsistent with, a position the applicant takes in: (i) Opposing an argument of unpatentability relied on by the Office, or (ii) Asserting an argument of patentability

PATENT LAWS 35 U.S.C.

§102. Conditions for patentability; novelty and loss of right to patent

A person shall be entitled to a patent unless--

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or

(c) he has abandoned the invention, or

(d) the invention was first patented or caused to be patented, or was the subject of an inventor's certificate, by the applicant or his legal representatives or assigns in a foreign country prior to the date of the application for patent in this country on an application for patent or inventor's certificate filed more than twelve months* before the filing of the application in the United States, or

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent, or

(f) he did not himself invent the subject matter sought to be patented, or

(g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

§103. Condition for patentability; non-obvious subject matter

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made. . . .

(c) Subject matter developed by another person, which qualified as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

* Six months for Design Applications (35 U.S.C. 172).